

# **Settlement Agreement October-December 2001 Report**



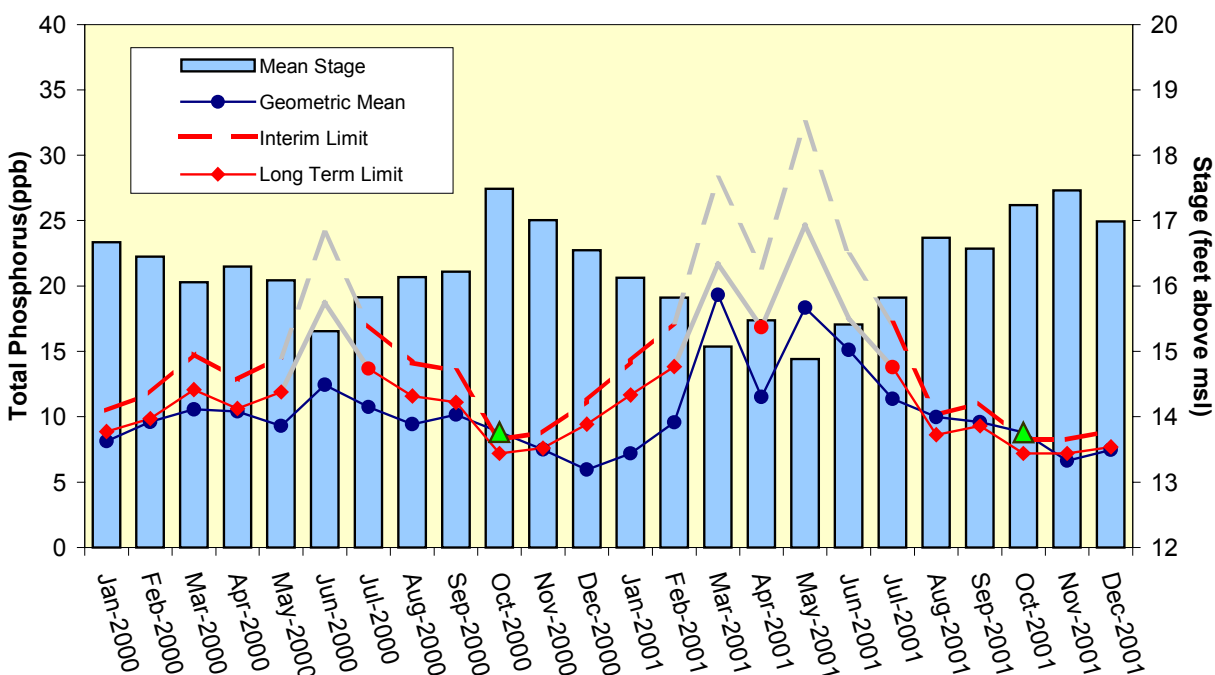
**Prepared for the  
Technical Oversight Committee  
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# ARTHUR R. MARSHALL LOXAHATCHEE NATIONAL WILDLIFE REFUGE

The 1991 Settlement Agreement ended the Everglades lawsuit and was entered into by the federal government, the State of Florida and the South Florida Water Management District. The subsequent Consent Decree, as modified in 1995, specified that interim and long-term phosphorus concentration levels for the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge) must be met by Feb. 1, 1999, and Dec. 31, 2006, respectively. The concentration levels vary monthly because they are calculated as a function of water stage measured at gaging stations 1-7, 1-8C and 1-9 within the Refuge. The stage range within which the interim and long-term concentration levels are applicable is 15.42 to 17.14 feet (mean sea level). The monthly total phosphorus concentrations are determined from water samples collected at 14 interior marsh stations (LOX 3 through LOX 16). As required in the Consent Decree, the concentrations are converted to a geometric mean, which is compared to the interim and long-term concentration levels.

Average stages in the Refuge were 17.24, 17.46 and 16.99 feet in October, November and December 2001, respectively (**Figure 1, Table 1**). The geometric means, calculated from total phosphorus concentrations measured in water samples collected in October, November and December, were 8.8, 6.6 and 7.5 ppb, respectively (**Table 1**). The October geometric mean concentration exceeded the calculated interim and long-term limits of 8.3 and 7.2, while the November and December geometric mean concentrations were less than the interim and long-term limits. Although the October geometric mean concentration was greater than the interim limit, the Settlement Agreement does not consider this situation to be an exceedance. "An exceedance occurs if the 14 station mean concentration is greater than the computed concentration level two or more times in any 12 consecutive sample collections". The last exceedance occurred in October 2000, *i.e.* 13 months prior to October 2001. The geometric means and calculated limits for both Octobers were identical (**Table 1**) most likely reflecting the decreasing phosphorus concentrations resulting from increasing stages that occurred in both years (**Figure 1**). Similar stage conditions also existed in October of 1997, 1998 and 1999. Only the long-term limit was exceeded in 1997 and 1998, but both limits were exceeded in October and November 1999 (**Table 1**).



**Figure 1.** Monthly total phosphorus geometric mean concentrations for the A.R.M. Loxahatchee National Wildlife Refuge compared to the interim and long-term limits. The calculated limit concentrations are adjusted for fluctuations in water level.

**Table 1. Loxahatchee National Wildlife Refuge Total Phosphorus Compliance Tracking.**

Month Year	Geometric Mean	Interim limit	Long Term Limit	Average Stage	Number of TP Samples	Number of Stage Measurements
	(ppb)			(ft,NGVD)		
Oct-1999	10.3	8.3	7.2	17.28	14	3
Nov-1999	9.0	8.3	7.2	17.25	14	3
Dec-1999	9.1	9.1	7.9	16.94	14	3
Jan-2000	8.1	10.5	8.9	16.67	14	3
Feb-2000	9.6	11.8	9.9	16.46	13	3
Mar-2000	10.6	14.8	12.1	16.06	12	3
Apr-2000	10.4	12.9	10.6	16.30	14	3
May-2000	11.0	15.0	12.2	16.05	14	3
Jun-2000	12.4	NA	NA	15.31	6	3
Jul-2000	10.8	17.0	13.7	15.84	6	3
Aug-2000	9.4	14.1	11.6	16.14	10	3
Sep-2000	10.2	13.5	11.1	16.22	11	3
Oct-2000	8.8	8.3	7.2	17.49	13	3
Nov-2000	7.5	8.8	7.6	17.01	14	3
Dec-2000	6.0	11.2	9.4	16.55	9	3
Jan-2001	7.2	14.3	11.7	16.13	8	3
Feb-2001	9.6	17.2	13.8	15.82	9	3
Mar-2001	19.3	NA	NA	15.08	2	3
Apr-2001	11.5	21.4	16.9	15.48	6	3
May-2001	18.3	N/A	N/A	14.88	2	3
Jun-2001	15.1	N/A	N/A	15.42	9	3
Jul-2001	11.4	17.2	13.8	15.82	11	3
Aug-2001	10.0	10.1	8.6	16.74	14	3
Sep-2001	9.6	11.1	9.3	16.57	14	3
Oct-2001	8.8	8.3	7.2	17.24	14	3
Nov-2001	6.6	8.3	7.2	17.46	14	3
Dec-2001	7.5	8.9	7.7	16.99	14	3

**Notes:**

(1) Average Stage is calculated using stage elevations at three stations on the sampling date

(2) The italicized values in parentheses for May-2000 included Lake Okeechobee Recession special sampling data.

(3) Highlighted values indicate months when exceedances occurred

# EVERGLADES NATIONAL PARK

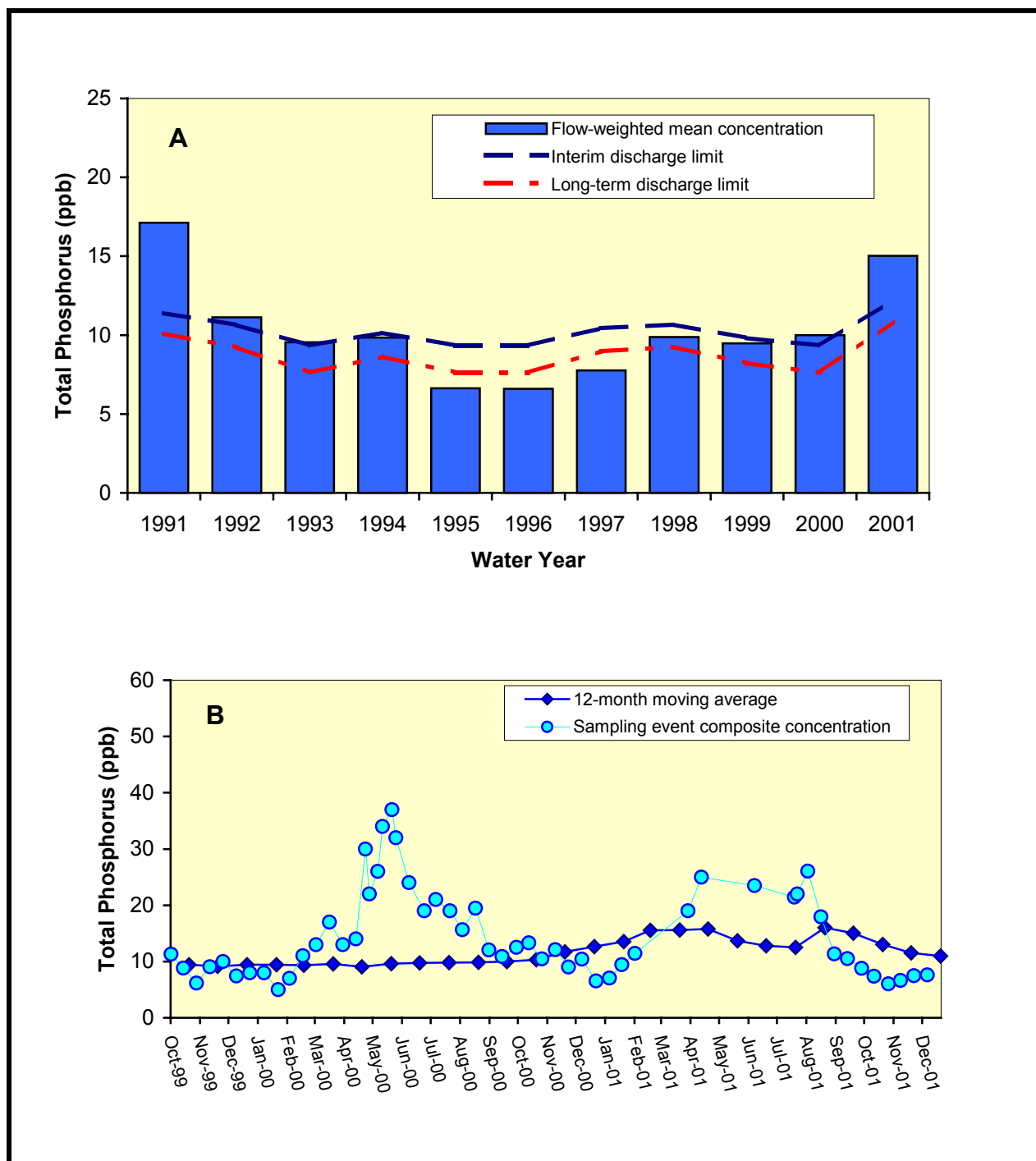
## Shark River Slough

The Consent Decree of 1995 specified that interim and long-term total phosphorus concentration limits for discharges into the Everglades National Park through Shark River Slough be met by October 1, 2003, and December 31, 2006, respectively. The limits apply to the water year ending September 30. The long-term total phosphorus concentration limit for inflows to Shark River Slough through structures S12A, S12B, S12C, S12D and S333 represents the concentrations delivered during the Outstanding Florida Waters baseline period of March 1, 1978 to March 1, 1979, and is adjusted for variations in flow. In addition, it is required that phosphorus concentrations be presented as 12-month moving flow-weighted means.

Inflow concentrations of total phosphorus through Shark River Slough are compared to the interim and long-term limits at the end of each water year from 1989 to 2001 (**Figure 2a**). The 12-month moving flow-weighted mean total phosphorus concentration ending September 2001 was 15.0 ppb. Corresponding interim and long-term limits were 12.2 and 10.8 ppb, respectively. This is the second consecutive year that both limits were exceeded for the water year ending in September. Both the 2000 and 2001 water years were very dry, resulting in lower volumes of flow with higher total phosphorus concentrations entering the Park than those observed in wetter years.

The Settlement Agreement stipulates that the percent of flow-weighted mean total phosphorus concentrations greater than 10 ppb from each sampling event in any 12-month period must not exceed an allowable value based on flow into Shark River Slough for the same 12-month period. For the 12-month periods ending October, November and December 2001, the percent of flow-weighted mean total phosphorus concentrations greater than 10 ppb were 68.4, 57.9 and 52.6 respectively (**Table 2**). These percentages exceeded the allowable percentages for all three 12-month periods. The individual sampling events and the 12-month moving average are presented in **Figure 2b**.

**Table 2** presents the moving flow-weighted mean concentrations for each 12-month period beginning in October 1999 as well as the corresponding interim and long-term total phosphorus concentration limits, which are calculated using the 12-month period flow. For the 12-month periods ending in October, November and December 2001, the flow-weighted mean total phosphorus concentrations were 13.0,



**Figure 2.** 12-month moving flow-weighted mean total phosphorus concentrations at the inflows to the Everglades National Park (ENP) through Shark River Slough compared to the interim and long-term targets. **A.** Concentration at the end of each water year. **B.** 12-month moving average concentration at the end of each month and the composite concentration for each sampling event

**Table 2.** Shark River Slough Total Phosphorus Concentration Compliance Tracking

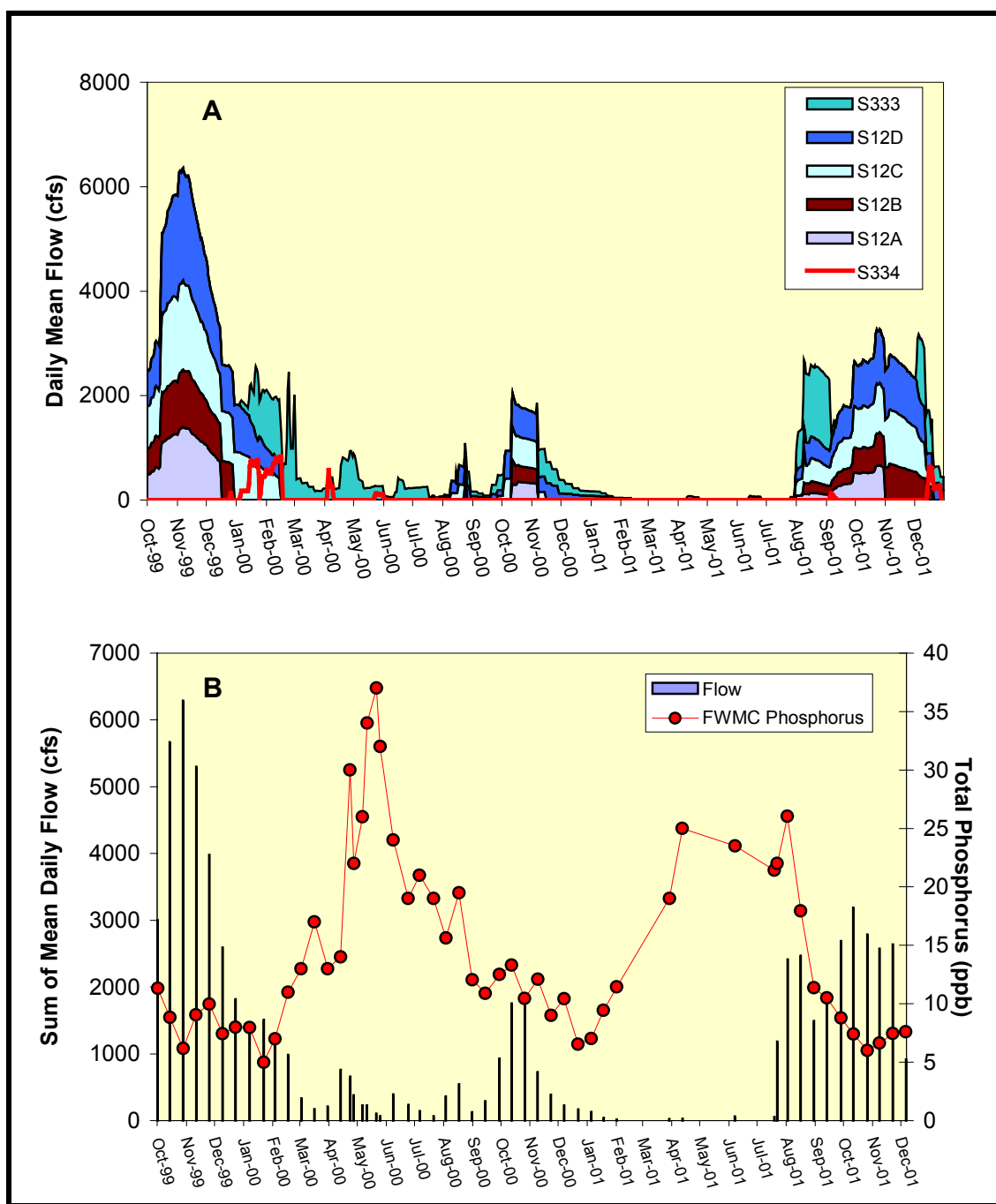
12-Month Period Ending On	Total Period Flow	Flow Weighted Mean Total Phosphorus	Limits		Percent of Sampling Events Greater than 10 ppb	
			(ppb)		(%)	
			Interim	Long Term	Observed	Allowed
10/31/99	1084.4	9.4	9.4	7.6	39.1	40.1
11/30/99	1297.5	9.1	9.4	7.6	39.1	40.1
12/31/99	1344.8	9.4	9.4	7.6	39.1	40.1
01/31/00	1395.1	9.4	9.4	7.6	39.1	40.1
02/29/00	1415.5	9.4	9.4	7.6	<b>41.7</b>	40.1
03/31/00	1385.7	9.6	9.4	7.6	<b>52.2</b>	40.1
04/30/00	1385.1	9.1	9.4	7.6	<b>52.2</b>	40.1
05/31/00	1401.5	9.6	9.4	7.6	<b>57.7</b>	40.1
06/30/00	1395.9	9.8	9.4	7.6	<b>60.7</b>	40.1
07/31/00	1294.6	9.8	9.4	7.6	<b>64.3</b>	40.1
08/31/00	1214.6	9.8	9.4	7.6	<b>65.5</b>	40.1
09/30/00	1096.1	10.0	9.4	7.6	<b>69.0</b>	40.1
10/31/00	925.0	10.3	9.9	8.3	<b>72.4</b>	43.2
11/30/00	642.1	11.7	11.1	9.8	<b>79.3</b>	50.8
12/31/00	464.0	12.7	12.0	10.8	<b>82.8</b>	56.4
01/31/01	367.0	13.5	12.5	11.3	<b>80.0</b>	59.8
02/28/01	298.4	15.5	12.9	11.7	<b>85.7</b>	62.2
03/31/01	275.9	15.6	13.0	11.9	<b>84.6</b>	63.1
04/30/01	250.4	15.8	13.2	12.0	<b>84.6</b>	64.0
05/31/01	230.9	13.7	13.3	12.1	<b>81.8</b>	64.7
06/30/01	221.0	12.8	13.3	12.2	<b>80.0</b>	65.1
07/31/01	212.8	12.5	13.4	12.2	<b>78.9</b>	65.4
08/31/01	324.0	16.0	12.8	11.6	<b>78.9</b>	61.3
09/30/01	419.7	15.0	12.2	11.0	<b>78.9</b>	57.9
10/31/01	502.4	13.0	11.8	10.5	<b>68.4</b>	55.2
11/30/01	599.2	11.5	11.3	10.0	<b>57.9</b>	52.1
12/31/01	677.9	11.0	10.9	9.6	<b>52.6</b>	49.8

Note: *Italicized values exceeded allowed percentage*

11.5 and 11.0 ppb, respectively. These flow-weighted mean concentrations were greater than the interim and long-term limits for each month of this quarter.

The daily mean flows through the individual Shark River Slough structures and S334 from October 1999 through December 2001 are presented in **Figure 3a**. A sharp increase in flow began on July 31, 2001, ending an essentially six-month no flow period. The relationship between the sum of the daily mean flows at Shark River Slough structures and the corresponding flow-weighted mean total phosphorus concentrations for individual sampling events is presented in **Figure 3b**. Increasing flows into Shark River Slough beginning in late July through December 2001 resulted in individual sampling event total phosphorus flow-weighted mean concentrations decreasing to 7.6 ppb by the end of December.





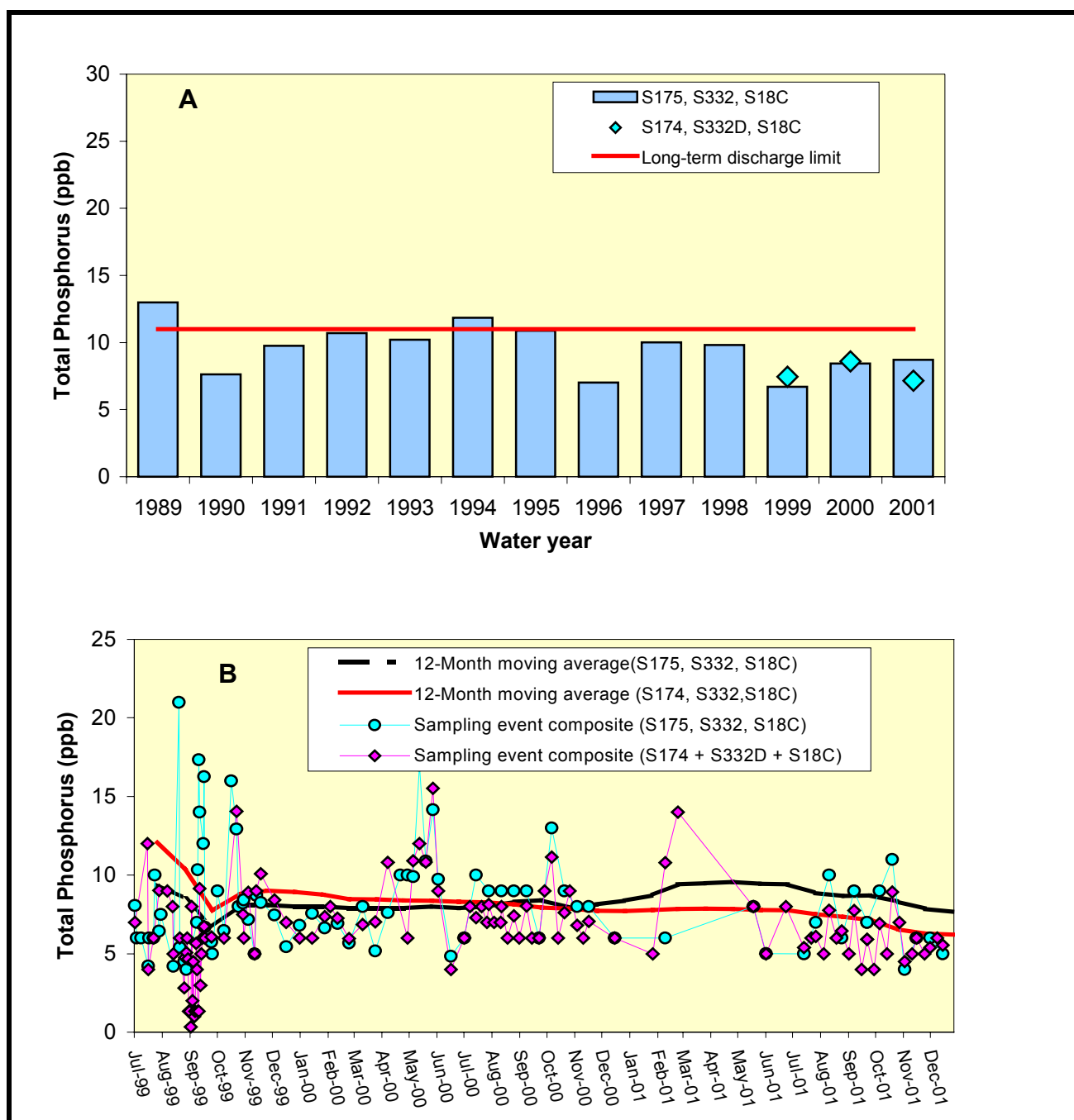
**Figure 3.** **A.** Mean daily flows into Shark River Slough by structure. **B.** The relationship between sum of mean daily flow at Shark River Slough structures and flow-weighted mean total phosphorus concentration for individual sampling events.

## Taylor Slough and The Coastal Basins

Under the Consent Decree, a single total phosphorus long-term limit of 11 ppb, to be met by December 31, 2006, was set for the two points of inflow to Taylor Slough (S332 and S175) and the inflow point to the Coastal Basins (S18C). The 11 ppb limit applies to the water year ending September 30. Beginning in August 1999, structure S332D, a new pump station constructed by the U.S. Army Corps of Engineers, began operation. The structure is adjacent to spillway S174 and pumps water from the L31N canal into the L31W canal. The S332D and S174 structures became the new inflow compliance monitoring sites for Taylor Slough on October 1, 1999, replacing S332 and S175. However, the Settlement Agreement's Technical Oversight Committee requested that data from both the old and new pairs of inflow structures to Taylor Slough be presented for one year. This request was made to determine if the differences between the two data sets observed from August 1999 through March 2000 would continue throughout a complete wet season/dry season cycle and what implications this might have on future compliance with the 11 ppb limit.

Inflow concentrations of total phosphorus to the Everglades National Park through Taylor Slough and the Coastal Basins are compared to the 11 ppb limit at the end of each water year using data from both the old (S175, S332, S18C) and new (S174, S332D, S18C) combinations of structures (**Figure 4a**). The bars in **Figure 4a** represent the flow-weighted mean total phosphorus concentrations from S332, S175 and S18C for water years 1989 through 2001. The diamond point values for water years 1999, 2000 and 2001 represent the new combination of structures. **Figure 4b** presents the 12-month moving average and individual sampling event flow-weighted mean total phosphorus concentrations at both the old and new combinations of structures. When the individual sampling event concentrations from both the old and new combination of structures (**Figure 4b**) are compared with the daily mean flow data presented in **Figure 5a**, it appears that the variability between the data is less during higher flows than during low/no flow periods.

The 12-month flow-weighted mean concentrations for October, November and December 2001 were 6.5, 6.3 and 6.2 ppb, respectively, at the new combination of structures and 8.3, 7.8 and 7.7 ppb, respectively, for the old combination of structures (**Table 3**). The Settlement Agreement stipulates that the percent of flow-weighted mean total phosphorus concentrations greater than 10 ppb from each sampling event in any 12-month period must not exceed a fixed value of 53.1 percent. The percentage of flow-weighted mean total phosphorus concentrations greater than 10 ppb for the new combination was 8.0, 7.4 and 6.7 for the periods ending October, November and December, respectively. For these same periods, the percentage for the old combination was 7.1, 7.1 and 6.7, respectively (**Table 3**).



**Figure 4.** **A.** Flow-weighted mean total phosphorus concentration at the inflows to the Everglades National Park through Taylor Slough and the Coastal Basins compared to the 11 ppb long-term total phosphorus limit for each year. **B.** The 12-month moving average and individual sampling event flow-weighted mean total phosphorus concentrations at both the old and new combinations of compliance monitoring sites.

**Table 3.** Taylor Slough and the Coastal Basins Total Phosphorus Concentration Compliance Tracking

12-Month Period Ending On	Total Period Flow		Flow Weighted Mean Total Phosphorus		Long Term Limit	Percent of Sampling Events Greater Than 10 ppb			
	(ac-ft x 1000)		(ac-ft x 1000)			Observed (%)		Allowed (%)	
	New	Old	New	Old		New	Old	New	Old
7/31/99	212	276	12.1	9.4	11.0	37.0	25.5	53.1	53.1
8/31/99	215	288	10.4	8.5	11.0	25.8	16.7	53.1	53.1
09/30/99	214	280	7.8	6.7	11.0	19.4	12.1	53.1	53.1
10/31/99	256	339	8.8	8.1	11.0	22.6	17.1	53.1	53.1
11/30/99	266	365	9.0	8.1	11.0	23.5	15.4	53.1	53.1
12/31/99	290	414	8.9	8.0	11.0	22.9	15.4	53.1	53.1
01/31/00	318	450	8.8	8.0	11.0	22.9	15.4	53.1	53.1
02/29/00	342	479	8.5	7.9	11.0	21.6	15.0	53.1	53.1
03/31/00	352	485	8.5	7.9	11.0	22.2	15.4	53.1	53.1
04/30/00	358	493	8.4	7.9	11.0	20.0	12.8	53.1	53.1
05/31/00	363	493	8.4	8.0	11.0	23.7	14.6	53.1	53.1
06/30/00	349	467	8.3	7.9	11.0	23.7	16.7	53.1	53.1
07/31/00	364	457	8.3	8.0	11.0	20.5	17.1	53.1	53.1
08/31/00	389	445	8.1	8.3	11.0	20.5	18.0	53.1	53.1
09/30/00	399	432	7.9	8.4	11.0	17.5	14.3	53.1	53.1
10/31/00	399	375	7.9	7.9	11.0	16.3	12.1	53.1	53.1
11/30/00	375	315	7.7	8.1	11.0	14.6	13.8	53.1	53.1
12/31/00	351	266	7.7	8.4	11.0	15.0	14.3	53.1	53.1
01/31/01	308	205	7.8	8.7	11.0	15.4	15.4	53.1	53.1
02/28/01	282	168	7.9	9.4	11.0	21.6	16.7	53.1	53.1
03/31/01	269	161	7.9	9.5	11.0	22.9	18.2	53.1	53.1
04/30/01	260	154	7.9	9.6	11.0	20.6	20.0	53.1	53.1
05/31/01	254	153	7.8	9.4	11.0	12.9	11.8	53.1	53.1
06/30/01	248	147	7.8	9.4	11.0	10.0	6.7	53.1	53.1
07/31/01	243	146	7.5	8.9	11.0	10.7	6.7	53.1	53.1
08/31/01	237	145	7.3	8.7	11.0	11.5	7.1	53.1	53.1
09/30/01	235	143	7.2	8.7	11.0	11.5	7.1	53.1	53.1
10/31/01	235	136	6.5	8.3	11.0	8.0	7.1	53.1	53.1
11/30/01	270	152	6.3	7.8	11.0	7.4	7.1	53.1	53.1
12/31/01	296	161	6.2	7.7	11.0	6.7	6.7	53.1	53.1

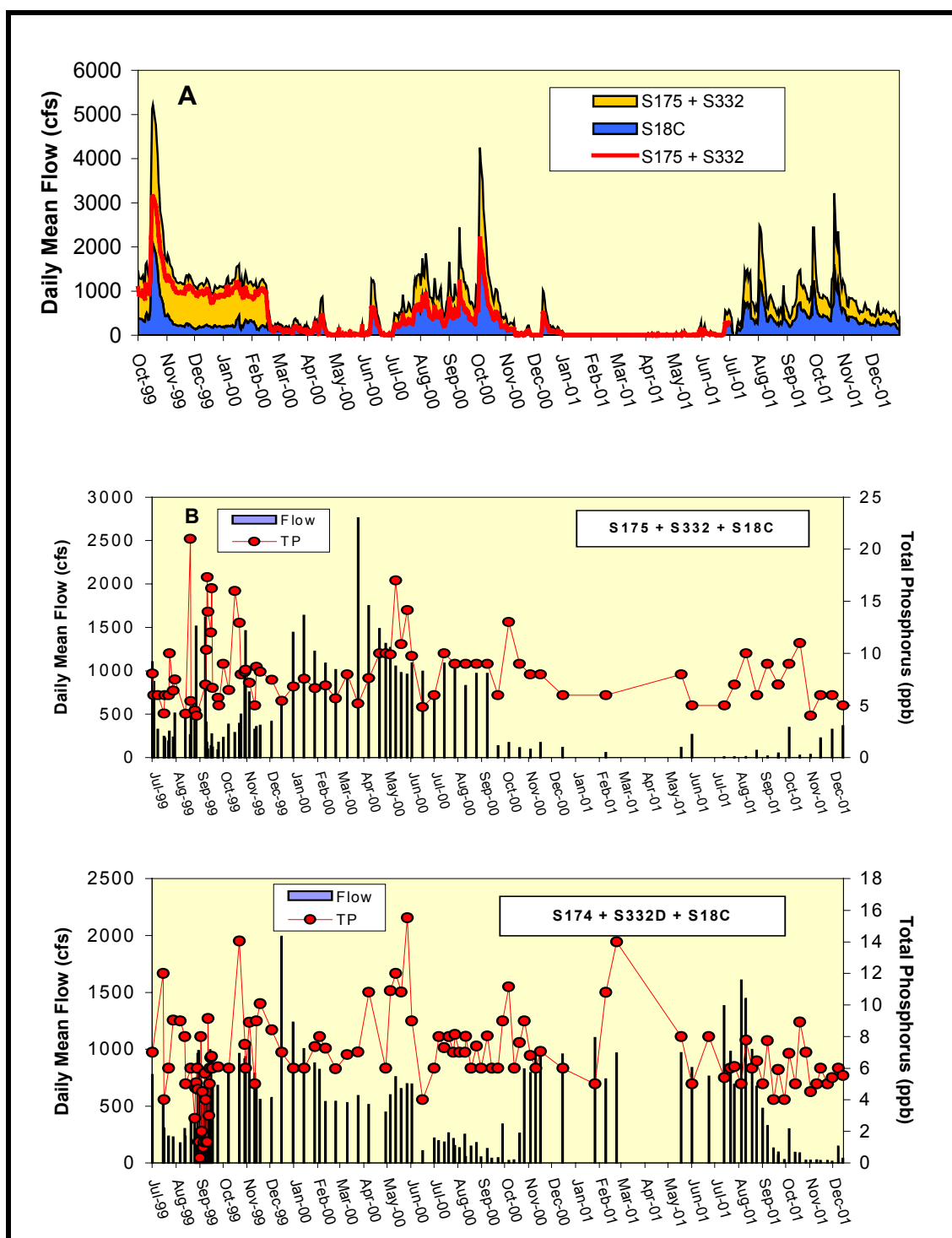
*New = S174 + S332D + S18C data*

*Old = S175 + S332 + S18C data*

A comparison of flows between the old and new combination of structures is presented in **Figure 5**.

The flow through S18C, along with the combined flows through S332 plus S175 and S332D plus S174, is presented in **Figure 5a**. The water discharged from the downstream structures, S175 and S332, is supplied through the upstream structures, S174 and S332D.

**Figure 5b** shows the sum of the daily mean flows at S18C and the Taylor Slough structures and the corresponding flow-weighted mean total phosphorus concentrations for each sampling event at both the old and new combinations of structures. As the data indicate, there is no linear relationship between daily mean flow and flow-weighted mean total phosphorus concentrations for either set of structures.



**Figure 5.** **A.** Daily mean flows into the Everglades National Park through Taylor Slough and the Coastal Basins control structure. **B.** Mean daily flows and corresponding flow-weighted mean total phosphorus concentrations at old and new combinations of Taylor Slough and Coastal Basin Structures.